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Review Article

# Review of self-reported instruments that measure sleep dysfunction in patients suffering from temporomandibular disorders and/or orofacial pain

Isabelle Sommer [a], Gilles Lavigne [b,c], Dominik A. Ettlin [a,*]

[a] Center for Dental Medicine, Clinic for Removable Prosthodontics, Masticatory Disorders and Special Care Dentistry, University of Zurich, Zurich, Switzerland
[b] Center for Advanced Research in Sleep Medicine, Hôpital du Sacré-Coeur de Montréal, Montreal, Canada
[c] Faculté de Médecine Dentaire, Université de Montréal, Canada

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ABSTRACT

Patients with temporomandibular disorders (TMD) and/or orofacial pain (OFP) frequently experience poor sleep quality or suffer from comorbid sleep disorders. Study results suggest that in chronic pain patients, an improvement in sleep quality critically influences the outcomes of interventions on mood and pain. Yet, only a few studies have systematically sought to evaluate the sleep quality of TMD/OFP patients. Standardized and validated self-reported instruments designed for screening sleep disturbances or for the evaluation of treatment outcomes in this population would therefore enhance evidence and improve treatment options. The objectives of the present study were: (1) to review the self-reported instruments that measure sleep dysfunction in studies on TMD/OFP patients, by conducting a systematic literature search; (2) to evaluate their clinimetric evidence; and (3) to provide guidance for future research using such instruments. A total of 26 papers, using eight different instruments, were identified. The most frequently used questionnaires and the only ones with good clinimetric properties were the Insomnia Severity Index followed by the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Scale. They were most reliable, valid and time-effective for measuring sleep dysfunctions in patients with TMD/OFP, with only a few practical constraints. Yet, in future studies, an assessment of the relationship between sleep disturbances and chronic pain will have to include instruments measuring the effect of mediator variables such as cognitive or emotional arousal. Research is required to clarify if existing self-reported questionnaires measuring these aspects will promote further insights or if there is a need for new instruments. This future research direction would blend into the overall biopsychosocial concept of TMD/OFP diagnoses and treatment.



## 1. Introduction

Orofacial pain (OFP) is part of the MESH[1] term 'facial pain', which is defined in PUBMED as:

> pain in the facial region including orofacial pain and craniofacial pain. Associated conditions include local inflammatory and neoplastic disorders and neuralgic syndromes involving the trigeminal, facial, and glossopharyngeal nerves. Conditions which feature recurrent or persistent facial pain as the primary manifestation of disease are referred to as facial pain syndromes.

Orofacial pain may more specifically be defined as pain and dysfunction primarily affecting the second and third division of the trigeminal nerve system. The prevalence of OFP in the general population is approximately 13% (range 1–48%) and has a greater prevalence among women [1,2]. The primary location of the pain has led to the establishment of OFP as a discipline in the field of dental medicine [3]. Chronic OFP is most commonly associated with temporomandibular disorders (TMD) [4].

Temporomandibular disorder is a collective term that embraces a number of clinical problems involving the masticatory muscles, the temporomandibular joints, and associated structures. Besides OFP, clinical manifestations of TMD may include limitation in jaw movements, and/or joint noises [5,6]. The etiology and underlying pathogenetic mechanisms of TMD are still not fully understood. Genetic predisposition, trauma, bruxism, peripheral neural mechanisms, central pain processing, psychosocial and other factors are commonly considered to be involved [5,7–10]. As for OFP, a greater prevalence of TMD has been observed in women

* Corresponding author. Universität Zürich, Klinik für Kaufunktionsstörungen, Schmerzsprechstunde, Plattenstrasse 11, CH – 8032 Zürich, Switzerland. Tel.: +41 44 634 34 54; fax: +41 44 634 43 12.
*E-mail address:* dominik.ettlin@zzm.uzh.ch (D.A. Ettlin).

[1] MESH (Medical Subject Headings) is the NLM controlled vocabulary thesaurus used for indexing articles for PUBMED.

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[4,5,11], which is associated with greater pain and a different age distribution of prevalence of TMD than males [12,13].

Temporomandibular disorders/OFP share features and are often associated with other chronic pain conditions (eg, tension headaches, fibromyalgia, chronic fatigue syndrome, irritable bowel syndrome) that are characterized by neuroendocrine abnormalities, frequent biopsychosocial distress, and complaints including fatigue, sleep disturbances, anxiety, and depression [10,14–21].

The variation in sleep between species and during their lifespan suggests that sleep may have many functions and, thus, generating a sleep definition is a daunting task [22,23]. Sleep disturbances do, however, impair quality of life and are one of the most widespread comorbid conditions in chronic pain patients [16,18,24–26]. The prevalence of sleep-related disturbances in clinical samples of chronic pain patients is typically greater than in the general population, and is often reported in the 50–70% range or higher [4,24,26,27]. Pain may be associated with sleep instability, disruption of non-rapid eye movement (REM) to REM sleep cycles continuity and excessive sleep fragmentation [24], which may in turn increase the perception of unrefreshing or nonrestorative sleep (NRS). Non-restorative sleep refers to the subjective experience of sleep as insufficiently refreshing or to the feeling that sleep is restless, light or of poor quality, even though traditionally assessed objective sleep parameters (eg, total duration, sleep stage distribution) appear to be normal [25,28]. Different etiologies for NRS and insomnia symptoms, such as difficulty initiating or maintaining sleep, are discussed in the literature [29].

Pain-associated sleep arousals and/or other markers of sleep discontinuity (eg, sleep-related movement arousals, respiratory-related arousals) identified either by self-report or by polysomnography (PSG) may impair sleep quality. Reciprocally, insufficient sleep (namely sleep deprivation) or poor sleep quality may induce pain hypersensitivity, exacerbate pain responses, and alter mood states, without clearly understood pathomechanisms [24,30–32].

It has been demonstrated that insomnias, which are associated with chronic pain, are often phenotypically similar to primary insomnia [33]. Insomnia is defined as a complaint of prolonged sleep latency, difficulties in maintaining sleep or the experience of nonrefreshing or poor sleep, which have to be coupled with impairments in daytime functioning such as lack of concentration, dysphoria, fatigue, and other symptoms [34,35]. Similarly, the most common sleep-related complaints of pain patients are delayed sleep onset, restless sleep, frequent awakenings, and NRS [4,18,36]. It has been suggested that the primary impairment is in the perception of sleep quality, rather than in real sleep performance *per se*, particularly for patients with high levels of pain [4]. The relationship between pain and poor sleep is often assumed to be bidirectional (poor sleep exacerbates pain, while greater pain adversely affects sleep [26]). This model was challenged by the results of Tang et al., who indicated that presleep pain was not a reliable predictor of subsequent sleep in a heterogeneous sample of 119 chronic pain patients with concomitant insomnia. Instead, they found that sleep efficiency and quality are best predicted by the presence of presleep cognitive arousal, while on the other hand, sleep quality was a consistent predictor of pain [37].

Only a few studies have systematically sought to evaluate sleep quality and sleep disturbances of TMD/OFP patients [10,21,38], although 60% of OFP patients responded affirmatively to a question about sleep disturbance. Furthermore, 77% of a cohort of OFP patients reported a reduction of their sleep quality since the onset of their pain, and investigations have consistently found that over 50% of TMD patients report poor sleep quality [4,10,16]. In their comprehensive PSG study of sleep in a well characterized sample of myofascial TMD patients, Smith et al. diagnosed high rates of different sleep disorders [10]: 75% met self-report criteria for sleep bruxism (SB), 17% met PSG criteria for SB, 36% met criteria for insomnia, and 28.4% were diagnosed with sleep apnea syndrome (SAS). Primary insomnia (PI) comprised the largest subcategory of insomnia (26%), while psychophysiologic insomnia (20.8%) comprised the largest subcategory of PI.

In summary, it may be said that there are similarities between populations of TMD/OFP and other chronic pain patients, concerning the higher prevalence of females and the prevalence of sleep disturbances, while SB and SAS are more frequent in TMD/OFP.

The aim of the present, comprehensive review was to: (1) review the self-reported instruments that measure sleep dysfunction in studies on TMD/OFP patients; (2) evaluate their clinimetric evidence; and (3) provide guidance for future research using such instruments.

## 2. Methods

In March 2013, a systematic literature search was conducted on three literature databases (PUBMED, EMBASE, and PsycInfo) to identify articles that used instruments to measure sleep disturbances in populations of TMD/OFP patients; it was updated in August 2013. The search was limited to human, adult papers that were published in English between 2002 and 2013. Only full-text articles targeting outcome measures were selected. The comprehensive search strategy used the following terms and their variants: (sleep[title/abstract]) and (instrument) or (assessment) or (questionnaire) or (interview) or (diary) and (TMD[title/abstract]) or (temporomandibular[title/abstract]) or (orofacial pain[title/abstract]). The search results were supplemented by hand-searching the relevant journals and reference lists from 2002 to present day, with regards to included and excluded studies. Figure 1 shows the literature-search strategy with its different steps and criteria for inclusion or exclusion of papers.

## 3. Results

### 3.1. Number of studies found

A total of 26 articles, which focused on patients with TMD and/or OFP and included an instrument measuring sleep disturbances, were found; they contained eight different instruments. The most frequently used type of instrument was a questionnaire, among which the Pittsburgh Sleep Quality Index (PSQI) (15/26 papers) was most commonly applied, followed by the Epworth Sleepiness Scale (ESS) (5/26 papers); one study used an interview. None of the studies employed sleep diaries. For more details see Table 1.

### 3.2. Purposes and aims of the various sleep measurements used in studies on TMD/OFP

The choice of instrument used to measure sleep disturbances and their related consequences depended on the type or symptoms that the studies focused on: The PSQI and the Sleep Assessment Questionnaire (SAQ) were used to measure patient-reported sleep quality, independent of the type of sleep disorder. In two cases, the PSQI total score was used to distinguish between poor and good sleepers [10,21]. Rai and Kaur [45] additionally used the PSQI to measure the number of hours spent in bed, the number of and reasons for awakenings, and difficulty returning to sleep. Two further studies only used one PSQI subscale (# 1 or # 6) to assess sleep quality [39,47]. The ESS was used for the assessment of excessive daytime sleepiness (EDS) in TMD/OFP patients [10] and in TMD patients suffering from SAS [50–52] and/or SB [49]. In addition to the ESS, the Fletcher and Luckett questionnaire was used to assess symptoms of SAS and EDS [51], while the Douglass Sleep Disorders Questionnaire (SDQ) was used for the diagnosis of SAS only [50]. The Insomnia Severity Index (ISI) was used to measure insomnia severity [10,57,60]. The Jenkins Sleep Problems Scale (JSPS) was used to build sleep disturbance scores [59]. In one study, a modified version of the

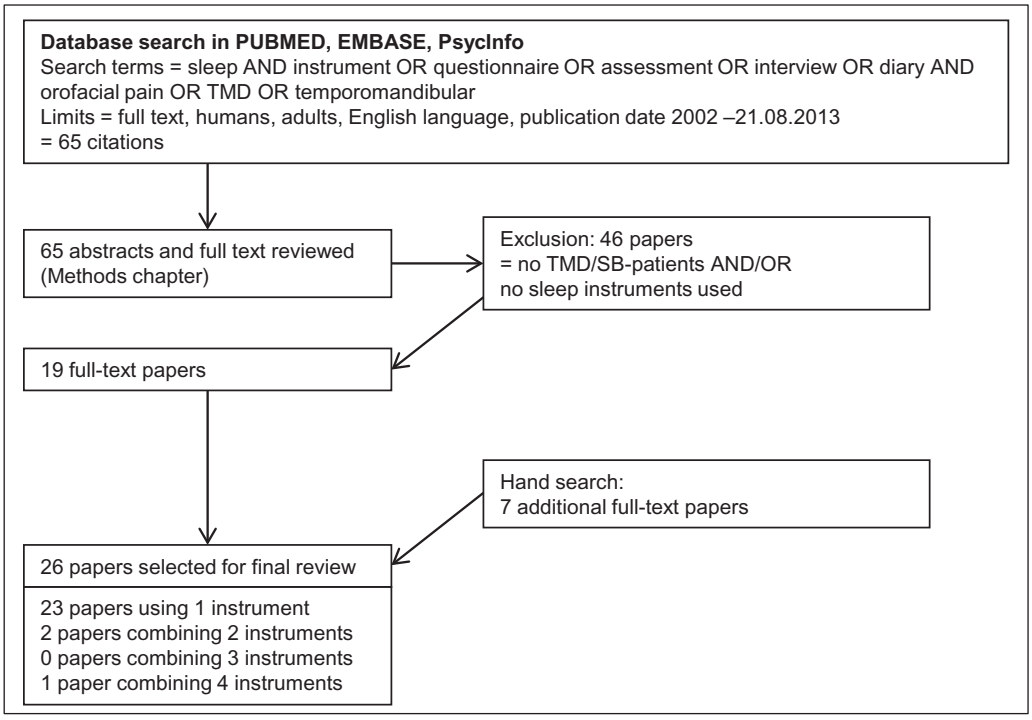


**Fig. 1.** Literature-search strategy: different steps and criteria for inclusion or exclusion of papers. SB = sleep bruxism; TMD = temporomandibular disorders.

Structured Interview for Sleep Disorders (SIS-D) was administered to diagnose Diagnostic and Statistical Manual of Mental Disorders (DSM) Axis-I and Axis-III sleep disorders based on DSM-IV revisions [10]. A single study used a battery of four measures to quantify sleep quality and daytime symptoms associated with sleep disorders, but the purpose of each instrument was not declared [10].

### *3.3. General description and clinimetric evaluation of the sleep instruments found*

For all instruments presented in this systematic review, validity studies are currently lacking for patients suffering from TMD/OFP. Importantly, however, their primary clinimetric focus is sleep dysfunction independent of comorbidities (eg, various types of pain, metabolic disorders, cancer, diverse psychiatric disorders, etc.). To confirm that these instruments truly measure what they claim, validity studies were additionally performed in patients with sleep disturbances as a secondary complaint. Notably, across the instruments presented, evidence for their clinimetric properties varies, as presented in Table 2.

The PSQI [62] is an 18-item, commonly employed, self-report questionnaire that assesses general sleep quality. It is not specific for any single primary sleep disorder. It has been widely translated and employed in a wide range of population-based and clinical studies [63]. It provides information on the number of hours of sleep, the number of awakenings during sleep, sleep latency, sleep efficiency, and the use of sleep medication. The PSQI has been shown to be a valid and reliable instrument for assessment of overall sleep quality and disturbance, with good test–retest reliability and internal consistency [64]. The questionnaire is easy to handle and can be completed within 5–10 min. For more details see Table 2.

Johns developed the ESS in 1991 [3]. It was designed to quickly and conveniently measure daytime sleep propensity in populations suffering from a variety of sleep disorders. The scale comprises eight items that address typical day-to-day situations; respondents are asked to rate their likelihood of dozing off in each situation. The ESS is a very popular research and clinical tool and is available in several languages. The ESS has good internal consistency and reliability [60,65–67] and has been compared with external criteria, including the multiple sleep latency test (MSLT) and the

**Table 1**
Summary of instruments used for measuring sleep dysfunctions in TMD/OFP patients.

| Measure | Type of instrument | Type/symptoms of sleep dysfunction | Number of studies using this instrument | References |
|---|---|---|---|---|
| Pittsburgh Sleep Quality Index (PSQI) | Questionnaire | Sleep quality; distinction of poor vs good sleepers | 15 | [5,10,16,19,21,39–48] |
| Epworth Sleepiness Scale (ESS) | Questionnaire | EDS | 5 | [10,49–52] |
| Sleep Assessment Questionnaire (SAQ) | Questionnaire | Sleep quality | 4 | [53–56] |
| Insomnia Severity Index (ISI) | Questionnaire | Insomnia severity; daytime symptoms | 3 | [10,57,58] |
| Douglass Sleep Disorders Questionnaire (SDQ) | Questionnaire | SAS diagnostic | 1 | [50] |
| Fletcher and Luckett sleep questionnaire | Questionnaire | EDS and SAS symptoms | 1 | [51] |
| Jenkins Sleep Problems Scale (JSPS) | Questionnaire | Sleep disturbance scores | 1 | [59] |
| Structured Interview for Sleep Disorders (DSM-III-R) (SIS-D) | Interview | Sleep disorder diagnostics | 1 | [10] |

*Abbreviations:* EDS = excessive daytime sleepiness; ESS = Epworth Sleepiness Scale; ISI = Insomnia Severity Index; JSPS = Jenkins Sleep Problems Scale; PSQI = Pittsburgh Sleep Quality Index; SAQ = Sleep Assessment Questionnaire; SAS = sleep apnea syndrome; SDQ = Douglass Sleep Disorders Questionnaire; SIS-D = Structured Interview for Sleep Disorders (DMS-III-R); TMD/OFP = temporomandibular disorders and/or orofacial pain.

**Table 2**
Description of instruments that primarily focus on aspects of sleep quality and insomnia.

| | | Pittsburgh Sleep Quality Index (PSQI) | Sleep Assessment Questionnaire (SAQ) | Insomnia Severity Index (ISI) | Jenkins Sleep Problems Scale (JPSP) | Structured Interview for Sleep Disorders (SIS-D) |
|---|---|---|---|---|---|---|
| General description | Type of measure | Questionnaire | Questionnaire | Questionnaire | Questionnaire | Interview |
| | Number of items | 18 + 5 additional questions rated by roommate or bed partner (not scored) | 17 | 7 | 4 | Not available |
| | Number of scales | Seven subscales | Six factors | No subscales | No subscales | No subscales |
| | Purpose | (1) Assessment of overall sleep quality<br>(2) Discrimination between good and poor sleepers<br>(3) Assessment of multiple sleep disturbances<br>(4) Not designed to provide clinical diagnoses. | (1) Sleep evaluation<br>(2) Screening for sleep apnea, psychophysiologic/ idiopathic insomnia, RLS/ PLMS, narcoleptic/ idiopathic hypersomnia<br>(3) Assessment of treatment response<br>(4) Assessment of overall sleep quality. | (1) Cognitive–behavioral<br>(2) Insomnia screening<br>(3) Assessment of treatment response. | (1) Epidemiology<br>(2) Evaluation of frequency and intensity of sleep difficulties. | (1) Epidemiology<br>(2) Structured clinical interview that can be used by experienced psychiatric interviewers for screening of patients with sleep disorders and for sleep research. Allows diagnostic assessment according to DSM-III-R. |
| | Content | (1) Subjective sleep quality<br>(2) Sleep onset latency<br>(3) Sleep duration<br>(4) Sleep efficiency<br>(5) Sleep disturbances<br>(6) Use of sleeping medication<br>(7) Daytime dysfunction. | (1) Insomnia/hypersomnia<br>(2) Non-restorative sleep<br>(3) Sleep schedule disorder<br>(4) Excessive daytime somnolence<br>(5) Sleep apnea<br>(6) Restlessness. | (1) Severity of sleep-onset<br>(2) Sleep maintenance<br>(3) Early morning awakening problems<br>(4) Satisfaction with current sleep<br>(5) Interference with daily functioning<br>(6) Impairment attributed to the sleep problem<br>(7) Level of distress caused by sleep problem. | (1) Trouble falling asleep<br>(2) Awakenings<br>(3) Trouble staying asleep<br>(4) Daytime impairment. | Primary sleep disorders (dyssomnias: insomnias, hypersomnias, sleep–wake schedule disorders, other dyssomnias; parasomnias: dream anxiety disorder, sleep terror disorder, sleepwalking disorder, other parasomnias); secondary sleep disorders (axis III diagnosis). |
| Clinimetric properties | Reliability | Cronbach's alpha: 0.83;<br>Item-total correlations: 0.20–0.66;<br>Test–retest reliability: 0.85, $p < 0.001$ (for global score) | No data available | Cronbach's alpha: 0.74–0.78;<br>item-total correlations: 0.36–0.67, mean 0.54;<br>Test–retest-reliability: no data | Cronbach's alpha: 0.63–0.79;<br>item-total correlations: 0.69–0.79;<br>test–retest reliability: 0.59, $p < 0.001$ | Cronbach's alpha: not available<br>Item–total correlations: not available<br>Test–retest-reliability: high level attained with respect to current (4-week) diagnoses. Acceptably high for lifetime diagnoses. |
| | Validity | Content: no information available<br>Criterion: good, distinguishes good from poor sleepers. | No data available | Content: good face validity<br>Criterion: significant correlations with relevant PSG data before and after treatment. | Preliminary evidence for construct validity. | Content: good, meets DSM-III-R criteria.<br>Criterion: good concordance between diagnoses and PSG data. |
| | Sensitivity/specificity | Cut-off score >5 distinguished patients from normal control with sensitivity = 89.6%, specificity = 86.5%. | Sensitivities between 79% and 100% and specificities between 68% and 96% depending on factor. | Cut-off score 14 distinguished patients from normal controls with sensitivity = 94%, specificity = 94%. | Not established | Not established |
| | Sensitivity to change | Yes, although not designed as treatment outcome measure. | No data available | Yes | Yes | Not established |
| Instrument development | Sample characteristics | Patients with major depression and patients with sleep disorders, including control group of good sleepers. | Patients with obstructive sleep apnea, fibromyalgia, chronic fatigue syndrome. | Adults (ages 17–84) with insomnia complaints (primary and secondary to medical, psychiatric, or other sleep disorders). | Air traffic controllers, aged 25–49 years and patients admitted for coronary bypass or cardiac valve surgery, aged 25–69 years. | Patients with major complaints of sleep disturbances (57% were referred to a sleep laboratory for further examinations, 33% were psychiatric inpatients with sleep disturbances as major symptoms. |
| | Other uses | War veterans, elderly people, sleep apnea, fibromyalgia, and others. | Patients with psychophysiological or idiopathic insomnia, RLS/PLMS, narcoleptic/idiopathic hypersomnia. | Young adults (mean age 20 years) and older adults (mean age 65 years) with primary insomnia. | No | No |

(*continued on next page*)

**Table 2** (*continued*)

| | | Pittsburgh Sleep Quality Index (PSQI) | Sleep Assessment Questionnaire (SAQ) | Insomnia Severity Index (ISI) | Jenkins Sleep Problems Scale (JPSP) | Structured Interview for Sleep Disorders (SIS-D) |
|---|---|---|---|---|---|---|
| Instrument characteristics | Administration | Self; paper and pencil; 5–10 min to complete. | Self; no further information available. | Self: paper and pencil; max. 5 min to complete. | Interview or self; paper and pencil; 2–5 min to complete. | 20–30 min for trained interviewers. |
| | Response options | Items 1–4: free entry; Items 5–18: 4-point Likert-scale (0 = not during the past month, 3 = three or more times a week); Item 19: 4-point Likert-scale (0 = very good, 3 = very bad sleep quality); global score range: 0–21. | 5-point Likert scale (1 = never; 5 = always); global score range: 0–68. | 5-point Likert-scale (0 = not at all, 4 = extremely); global score range: 0–28. | 6-point Likert scale (0 = not at all, 5 = 22–31 days). | |
| | Reference period | Past 4 weeks | No data available | Past 2 weeks | Past month | Past 4 weeks or lifetime (only for axis I diagnoses) |
| | Simple Scoring | No, assignment of ordinal values to quantitative and qualitative items. The seven component scores are summed to a global score. Scoring instructions are provided in the original publication. | No information available for screening use; summary score for assessment of overall sleep quality. | Yes, summary score. | Yes | No, knowledge on sleep disorders is needed. |
| | Accessible interpretation | Yes; higher global scores indicate poorer sleep quality. | Yes; higher global scores indicate poorer sleep quality. | Yes, suggested guidelines:<br>0–7 = no clinically significant insomnia<br>8–14 = subthreshold insomnia<br>15–21 = moderate clinical insomnia<br>21–28 = severe clinical insomnia. | Yes; higher scores indicate more acute sleep difficulties. | Yes |
| | Cut-off score | Yes, global score >5 = severe difficulties in at least two domains, or moderate difficulties in more than three domains, distinguishes good from poor sleepers. | No data available. | Yes, 14. | No | No |
| | Norm reference | No | No data available | No | No | No |
| Versions | Other forms | No | No data available | Clinician-administered, significant other and French language versions available. | No | Modified version to reflect DSM-IV revisions (see: original use with TMD, above). |
| | Validated translations[a] | German, French, Italian, Japanese, Taiwanese, Korean, Persian, Brazilian, Greek, Hebrew | No | Spanish, Hindi, Arabic | No | No |

*Abbreviations:* ISI = Insomnia Severity Index; JSPS = Jenkins Sleep Problems Scale; PSQI = Pittsburgh Sleep Quality Index; SAQ = Sleep Assessment Questionnaire; SIS-D = Structured Interview for Sleep Disorders (DMS-III-R).

[a] Pubmed search containing "validation" AND "version" AND full name of the measure.

**Table 3**
Description of instruments that primarily focus on the aspects of EDS and SAS.

| | | Epworth Sleepiness Scale (ESS) | Douglass Sleep Disorders Questionnaire (SDQ) | Fletcher and Luckett sleep questionnaire |
|---|---|---|---|---|
| General description | Type of measure | Questionnaire | Questionnaire | Questionnaire |
| | Number of items | 8 | 45 | 25 |
| | Number of scales | No subscales | Four subscales: SA, sleep apnea scale; PLM, periodic limb movement disorder scale; PSY, psychiatric sleep disorder scale; NAR, narcolepsy scale | No subscales |
| | Purpose | (1) Screening of overall daytime sleepiness (2) use in research. | (1) Sleep evaluation (2) Screening for major sleep disorders. | (1) Epidemiology (2) Screening for sleep disturbances (at night- and daytime). |
| | Content | Likelihood to fall asleep in eight different situations. | Questions about various symptoms often associated with (1) sleep apnea, (2) periodic limb movement disorder, (3) narcolepsy, (4) psychiatric sleep disorders. | (1) Excessive daytime sleepiness (2) Parasomnias (3) Obstructive sleep apnea syndrome (4) Daytime impairments. |
| Clinimetric properties | Reliability | Cronbach's alpha: 0.75–0.83; Item-total correlations: 0.41–0.64; Test–retest reliability: 0.85, $p < 0.001$ (for global score) | Cronbach's alpha: 0.85; Item-total correlations: 0.19–0.71; Test–retest-reliability: SA 0.84, NAR 0.75, PSY 0.84,PLM 0.81, all $p < 0.0001$. | No data available |
| | Validity | Content: no information available criterion: good, distinguishes normal controls from patients with different types of hypersomnia; convergent and discriminant validity were established. | Content: good face validity criterion: significant correlations with relevant PSG data before and after treatment. | No data available |
| | Sensitivity/specificity | Cut-off score >10 distinguishes between normal and excessive daytime sleepiness with sensitivity = 93.5%, specificity = 100%. | Only provisional data available | No data available |
| | Sensitivity to change | Yes | No data available | No data available |
| Instrument development | Sample characteristics | Patients with various sleep disorders and controls with history of normal sleep habits without snoring, ages ranging from 18 to 78 years. | $N = 435$ clinical sleep-disorder patients in four groups: $n = 158$ sleep apnea, $n = 73$ narcolepsy, $n = 108$ psychiatric inpatients, $n = 96$ nocturnal myoclonus/PLMD and $n = 84$ normal controls | $N = 9$ OSA patients with stable nCPAP therapy for 6 months to 2 years; age 59.6 ± 6.1, $n = 7$ OSA patients, new nCPAP user; age 51.6 ± 12.8 |
| | Other uses | Obstetric population | No data available | No data available |
| Instrument characteristics | Administration | Self; paper and pencil; 2–5 min to complete | No data available | Self; no further information available |
| | Response options | Scale of 0–3 (0 = "would never doze", 3 = "high chance of dozing"); global score range: 0–24 | 5-point Likert scale | 4-point Likert scale (0 = never, 1 = rarely, 2 = occasionally, 3 = often) |
| | Reference period | Recent times | No data available | No data available |
| | Simple scoring | Yes, summary score | No data available | Yes, summary score, divided by 25 to determine the level of symptoms |
| | Accessible interpretation | Yes; higher global scores indicate higher daytime sleepiness | No data available | No; higher summary scores indicate higher levels of undefined sleep disturbances. |
| | Cut-off score | Yes, global score >10 for identifying daytime sleepiness at a potentially clinical level. | Yes, but only provisional data available. | No data available |
| | Norm reference | No | No | No data available |
| Versions | Other forms | No | No data available | No data available |
| | Validated translations[a] | German, French, Urdu, Arabic, Iranian, Croatian, Serbian, Chinese, Thai, Korean. | No data available | No data available |

*Abbreviations:* EDS = excessive daytime sleepiness; ESS = Epworth Sleepiness Scale; SAS = sleep apnea syndrome; SDQ = Douglass Sleep Disorders Questionnaire.
[a] Pubmed search containing "validation" AND "version" AND full name of the measure.

maintenance of wakefulness test (MWT) [60]. The questionnaire is easy to handle and can be completed within 5 min. For more details, see Table 3. In a confirmatory factor analysis, Smith et al. [60] found that the original single-factor structure proposed by Johns did not adequately fit the data. The authors therefore proposed a re-specified single-factor solution for patients with OSA.

The SAQ was developed to screen for primary sleep disorders and sleep abnormalities in epidemiologic studies [68,69]. It is a

17-item self-administered questionnaire. The items are scored on a 5-point Likert scale from 1 (never) to 5 (always). Factor analysis of the 17 items identified six sleep factors: insomnia, NRS, restlessness, daytime sleepiness, sleep apnea, and sleep schedule disorder. Receiver Operating Curves (ROCs) have been calculated for the total SAQ score, as well as for the factor scores (with exception of the sleep schedule disorder factor) to show the sensitivity/specificity at various cut-offs. It has been shown to be a highly sensitive and specific measure that is capable of discriminating between patients with different sleep disorders and between patients with sleep disorders and controls free of sleep disturbances [70–72]. For more details see Table 2.

The ISI is an instrument designed to assess the severity of both nighttime and daytime components of insomnia [73]. It is available in several languages and is increasingly used as a metric for treatment response in clinical research. It offers good clinimetric properties [74,75]. Its seven items correspond partly to DSM-IV criteria for insomnia [73], but correspond perfectly to DSM-V criteria[2] and measure current perceptions of insomnia-symptom severity, distress, and daytime impairment. Each of these items is rated on a 5-point Likert scale. Total scores range from 0 to 28, with high scores indicating greater insomnia severity. A cut-off score of 10 is optimal for detecting insomnia cases in a community sample [18]. The ISI is available in three different versions: patient (self-administered), significant others (usually a spouse), and clinician [73]. The questionnaire is easy to handle and can be completed within 5 min. For more details see Table 2.

The SDQ [76] was designed as a tool for identifying persons at high risk of a sleep disorder. The 175-item scale was created by selecting the best and most salient questions from the Sleep Questionnaire and Assessment of Wakefulness (SQAW), which is a general measure consisting of more than 800 items [77]. The scale was initially intended for general practitioners and other professionals outside the field of sleep medicine. The developers also created a smaller, 45-item version of the scale to assess four common sleep disorders: sleep apnea, narcolepsy, psychiatric sleep disorders, and periodic limb movement disorder. Good clinimetric qualities were found for the 45-item version [76]. For more details see Table 3.

The Fletcher and Luckett questionnaire[3] [78] consists of 25 questions about sleep, snoring nocturnal apnea, and daytime somnolence. The original purpose of the questionnaire was to determine the level of baseline OSA symptoms in a population of 20 OSA patients actively using nasal Continuous Positive Airway Pressure (nCPAP) for 6 months to 2 years. To achieve this, the total score was divided by 25. No data concerning the clinimetric evaluation is available (see Table 3).

The JSPS [79] was designed as an efficient and brief instrument for use in research. The four items evaluate the frequency and intensity of sleep disturbances on a 5-point Likert scale. Though the questionnaire is short, the authors suggest that it has been shown to possess good predictive value in previous studies [79]. With only four items, it cannot address the entire spectrum of sleep disorders and is thus to be considered as a preliminary screening device [79]. The average time for administration is 2–5 min. For more details see Table 2.

The Structured Interview for Sleep Disorders (SIS-D) [80] is a structured clinical interview that can be used by experienced psychiatric interviewers to assess sleep–wake disorders. Adequate administration requires training and careful study of the instruction manual. The interview consists of a brief semi-structured overview containing questions about: physical health; use of medication, drugs, or alcohol; history of mental illness; and more-specific screening questions on sleep apnea and narcolepsy. There is also a structured section that systematically inquires about specific symptoms of sleep disorders, and a summary score sheet to be filled in by the rater after completion of the interview. All axis-I diagnoses (according to DSM-III-R) can be evaluated as current or lifetime. Axis-III diagnoses (according to DSM-III-R) are evaluated only as current and are considered provisional until confirmed by sleep laboratory findings. The instructions for the SIS-D permit the interviewer to omit irrelevant sections and proceed to the next one. The average time for administration is 20–30 min [80]. It is the only published interview that demonstrates sound reliability and validity based on PSG and expert interviews [10]. For more details see Table 2.

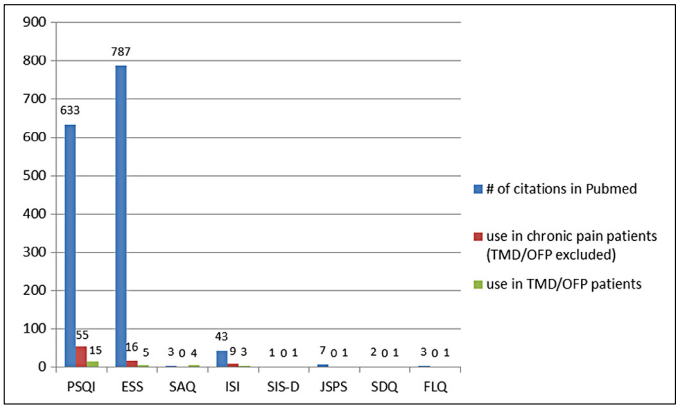


**Fig. 2.** Number of citations, studies on chronic paint patients (both May 2013) and studies on TMD/OFP patients using the sleep-related measures. (■) No. of citations in Pubmed, (■) use in chronic pain patients (TMD/OFP excluded), (■) use in TMD/OFP patients. FLQ = Fletcher and Luckett Questionnaire; TMD/OFP = temporomandibular disorders and/or orofacial pain. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

To provide information about the frequency of use in scientific publications of sleep disturbances, a brief Pubmed search was performed in May 2013 for each instrument, using the short and full name of the measure in quotation marks as search criteria (only adults). As shown in Fig. 2, the number of citations varies greatly between the most-frequently used (ESS, PSQI) and the rarely used measures. Comparing the number of citations, Fig. 2 shows that the ISI is the most-frequently used questionnaire for chronic pain patients (nine citations out of a total of 43, ie, 21%) and also for TMD/OFP patients (three citations of out of a total of 43, ie, 7%), followed by the PSQI (55 and 15 of 633, ie, 9% and 2% for chronic pain and TMD/OFP, respectively), while only 3% (21 of 787) of the studies using the ESS focused on chronic pain and TMD/OFP patients. The result that the SAQ returned less general citations than uses with TMD/OFP patients is due to the search strategy applied. The frequency of use of the instruments in TMD/OFP populations did not reflect the number of general citations, with rarely cited instruments being over-represented in the present study.

### *3.4. Overview of the results obtained in the studies using the PSQI, the ISI, and/or the ESS*

In summary, the three most-frequently-used questionnaires in the present study demonstrated their clinimetric properties and limitations in intervention, longitudinal, and correlative designs. A summary of the results obtained by the use of these instruments, as discussed by the authors of the respective studies, follows below, ordered by clinimetric properties:

[2] Personal information by Prof. Charles Morin, Université Laval, Québec, Canada (2014).

[3] No shortname published.

*3.4.1. Sensitivity to change*

In four cases, the PSQI was used in intervention studies. In two of these cases, it was shown that different types of psychological pain treatment (hypnosis or relaxation) decreased PSQI scores in intervals of 5 or 4 weeks, respectively [5,39]. Yet, the sensitivity to change of the PSQI was not thoroughly demonstrated, since a control group receiving no treatment at all is missing in both studies. In one of these cases, sleep quality was positively associated with self-care behavior like relaxation, application of hot/cold packs, and performing stretching exercises [46]. On the other hand, pharmacological treatment (clonazepam or cyclobenzaprine) applied over a 3-week interval failed to improve sleep quality [42].

In one case, the ISI was used in a longitudinal study over 12 weeks. This case showed that increases in either insomnia symptoms or usual pain ratings in the initial month were associated with next-month decreases in these constructs, respectively. Additionally, the authors also observed a significant association between initial-month changes in insomnia symptom severity and next-month increases in clinical pain, even controlling for prior changes in pain and concurrent changes in insomnia. According to the authors, these data suggest that naturally occurring fluctuations in insomnia symptom severity are prospectively associated with fluctuations in daily pain experience for persons with TMD/OFP [57].

In one case, the ESS was used in an intervention study, which showed that Mandibular Advancement Device (MAD) therapy did not influence ESS total scores [51]. According to the authors, this result may not be generalized because no objective measures of EDS were applied.

*3.4.2. Discrimination capacity between subgroups of TMD/OFP patients or between TMD/OFP patients and healthy controls*

In seven cases, PSQI total scores were used to discriminate between groups and showed that total scores were higher in TMD/OFP patients:

- with post-traumatic stress disorder syndrome (PTSD) symptoms compared with TMD/OFP patients without PTSD symptoms [16,40]
- compared with healthy controls [43,44]
- in the myofacial pain (MP) subgroup compared with the intracapsular pain (IC) subgroup
- compared with patients with chronic daily headache (CDH) [48].

There were no differences found in PSQI total scores in the TMD patients with neuropathic pain compared with myofacial pain [19] and no differences found in PSQI total scores in crew members reporting either TMD symptoms, simple muscle pain, or nothing, after being exposed to a simulated Mars mission for 6 days [45].

In two cases, PSQI cutoff scores (<5 and <10, respectively) helped to discriminate between poor and good sleepers in TMD/OFP populations [10,21].

In one case, the ISI was used to discriminate between poor and good sleepers in the TMD/OFP population and it was shown that ISI total scores were significantly higher in TMD/OFP patients presenting with a high-burden of suffering (PRISM-inself patients) compared with TMD/OFP patients presenting with a low-burden of suffering (PRISM-outself patients) [58].

In one case, the ESS cutoff value >10 was used to define the presence of EDS. It was shown that 19% of the TMD/OFP patients suffered from EDS compared with 10% in the healthy group [50].

In two cases, ESS total scores were used to discriminate between groups, showing slightly, but significantly higher values in TMD/OFP patients suffering from SB than in healthy controls [49] and significantly higher ESS total scores in TMD/OFP patients defined as poor sleepers than TMD/OFP patients defined as good sleepers [10].

*3.4.3. Analysis with correlation*

In one case, PSQI total scores were used to test a mediator hypothesis and it was shown that PTSD symptoms exert their influence on OFP through depression and sleep quality [41]. In the last of the total of 15 cases, poor self-rated sleep quality (PSQI item # 6) was a putative predictor of first-onset TMD in people with a high likelihood for OSA [47].

In one case, the ISI was probably used to diagnose insomnia – in addition to PSG – but an exact description concerning the contribution of the ISI to the diagnostic process has not been reported [10].

In one case, the decrease in ESS total scores and in other OSA symptoms of TMD/OFP free and TMD/OFP patients, both suffering from OSA, were used to determine the length of the titration period of MAD [52].

## 4. Discussion

To further the understanding of the comorbidities of TMD/OFP and sleep disturbances, researchers and clinicians require cost-effective and time-effective, standardized and validated instruments for screening and evaluating treatment outcomes. Selecting the 'best' instrument for clinical practice involves careful consideration of an instrument's ability to screen, diagnose and/or monitor sleep disorders, poor sleep quality and resulting daytime impairment [81]. The aim of the present study was, thus, to identify existing self-report instruments that measure sleep dysfunction in cohorts of TMD/OFP patients, to evaluate the strength of their clinimetric evidences, and to provide guidance for research and clinical practice.

### *4.1. General remarks on clinimetric evidences*

Instruments that measure sleep dysfunction aim to assess sleep parameters, independent of somatic or psychiatric comorbidities. Once the validity and reliability (ie, clinimetric evidence) of an instrument has been sufficiently demonstrated in a variety of ambulatory and/or clinical settings, its use can be expanded to any populations where measurements of sleep dysfunction are of interest. A key finding of the present review was that clinimetric soundness substantially varies across the instruments identified, as evidenced by: (1) reliability scores (eg, Crohnbach's alpha); (2) available information concerning content and/or criterion validity; (3) available sensitivity and specificity values; and (4) published information on sensitivity to change (Tables 2 and 3). The clinimetric soundness was strongest for PSQI, ISI, ESS and, to certain extent, SDQ. It was intermediate for SIS-D, and lowest for SAQ, JSPS, and the Fletcher and Luckett sleep questionnaire (Table 4).

The question arises as to whether sleep dysfunction in pain patients, specifically suffering from TMD/OFP, differs from other patient populations. As of today, no publication has identified a specific pain-related sleep dysfunction that would not be found in other populations. Rather, the most common sleep-related complaints of pain patients are phenotypically similar to primary sleep dysfunctions (eg, insomnia) [4,18,33,36]. Therefore, instruments with strong clinimetric properties do not require further testing in TMD/OFP patients.

### *4.2. General comparison of instruments that measure sleep dysfunction*

Measurement targets determine which type of instrument is best utilized to address a specific clinical or research question. Sleep questionnaires are good and cost-effective instruments for the purpose

of screening for sleep disturbances, for the assessment of subjective sleep quality and for monitoring treatment course and outcome [61,81,84,85]. Sleep interviews, on the other hand, provide more complex information, allow more valid diagnoses compared with questionnaires [80], and offer a better relationship with patients – especially in the semi-structured version. Their disadvantages include more time-consuming administration and, often, specific training for administration, scoring, and interpretation. The decision to use an interview requires careful consideration, because high agreement between results based on interviews and questionnaires has been found for chronic headache [86] and sleep problems [84].

Sleep diaries are useful for sleep assessment and tracking treatment effects [87]. They permit the evaluation of intra-individual variability across a study period, which is particularly advantageous when combined with daily pain ratings (eg, [88]). Sleep diaries can be specifically designed and customized as paper-and-pencil or electronic versions (eg, [37]). Yet, as stated by Buysse et al. in their recommendations for a standard research assessment of insomnia, the collective impact of sleep diary studies has been limited by a lack of standardization [89]. This has contributed to inconsistencies in study findings and compromised the ability to fully interpret and integrate results of previous studies [90]. There is agreement that sleep diaries should yield information about relevant metrics, including sleep onset latency (SOL), wakefulness after initial sleep onset (WASO), total sleep time (TST), total time spent in bed (TIB), sleep efficiency (SE = TST/TIB × 100%), and sleep quality or satisfaction, as a subjective global appraisal of each night's sleep. On the other hand, there is no agreement on the format of the sleep diary, that lead to multiple lab-specific versions as mentioned above [87]. The Consensus Sleep Diary (CSD) developed by Carney et al. is the result of collaborations with insomnia experts and potential users [87]. Other sleep diaries like the Karolinska Sleep Diary (KSD) and the Pittsburgh Sleep Diary (PSD) are examples described by Devine et al. [91].

Although examples with sound clinimetric properties do exist for each category of the previously mentioned self-reported instruments, their use for diagnostic purposes in sleep medicine is limited. The gold standard for the diagnosis of SAS and SB is laboratory-recorded or home-recorded PSG. The latter has major advantages because patients are in their natural sleep environment [92,93]. Polysomnography is superior to clinical examination for diagnosing SB because none of the clinical signs constitute direct proof of current SB activity [27,94]. For SB, contradictory findings have been published based on self-report versus those based on PSG, including masticatory muscle electromyography (EMG) and/or audio–video recordings [10,95,96]. The lack of internal validity of self-reported SB diagnosis is due to the fact that the self-reported assessments are mostly based on only one or two items of insufficient homogeneity [97]. This may sound surprising, since validated questionnaires for the assessment of SB do exist in the research milieu. This raises another issue: can a questionnaire designed for mechanistic research studies (ie, screening subjects with high likelihood of tooth grinding) be directly used in the general population without further validation [27,98]? The use of SB questionnaires may be a good alternative for collecting objective measurements in large groups of patients, such as EMG or PSG. However, self-reported measures of SB and other oral parafunctions have been criticized for the possibility that patients are unable to observe and report their own activities accurately and that further support is needed for more specific questions assessing the disorder of interest with possible co-morbidities [99].

Polysomnography is an uncommon tool with which to assess insomnia. The most common instrument to assess it is actigraphy; combined with sleep diaries, it is considered to be the gold

**Table 4**
Summary and appreciation of the clinimetric soundness of the instruments found in this study.

| Instruments | Clinimetric properties | | | | Critical appraisal | References |
|---|---|---|---|---|---|---|
| | Reliability | Validity | Sensitivity/specificity | Sensitivity to change | | |
| Pittsburgh Sleep Quality Index (PSQI) | Good | Good | Good | Information available | Good | [62,64] |
| Insomnia Severity Index (ISI) | Good | Good | Excellent | Information available | Good | [74,75] |
| Epworth Sleepiness Scale (ESS) | Good | Good | Excellent | Information available | Good | [33,65–67] |
| Douglass Sleep Disorders Questionnaire (SDQ) | Good | Good | Provisional data available | No information available | Good | [76] |
| Structured Interview for Sleep Disorders (SIS-D) | Good | Good | No information available | No information available | Intermediate | [60,80] |
| Sleep Assessment Questionnaire (SAQ) | No information available | No information available | Good to excellent | No information available | Insufficient | [70,71,82] |
| Jenkins Sleep Problems Scale (JPSP) | Preliminary evidence | Preliminary evidence | No information available | Information available | Insufficient | [79] |
| Fletcher and Luckett sleep questionnaire | No information available | No information available | No information available | No information available | Insufficient | [78] |

Evaluation criteria for the critical appraisal.
*Reliability:*
Good = Cronbach's alpha and/or test–retest reliability and/or item-total correlation >0.8.
*Validity:*
Good = high correlation between the test and a criterion variable (or a gold standard) taken as representative of the construct ($r > 0.8$) and/or capacity to distinguish good from bad sleepers or normal controls from patients.
*Sensitivity/specificity:*
Excellent = sensitivity and specificity as close to 100% as possible and cut-off score published.
Good = sensitivity and specificity as close to 100% as possible, no cut-off score published.
*Sensitivity to change:*
Sensitivity to change is unclearly defined. Two of the most-used definitions are "the capacity of a measure to detect change in patients' status over time" or "the clinical meaningfulness of changes in scores" [83].
Good = information available, independent of the definition chosen.
*Final appraisal:*
Good = report of the results of validation was published and all criteria appraised as good.
Intermediate = report of the results of validation incompletely published, but good reliability and validity.
Insufficient = report to the results of validation incompletely published or unpublished.

standard for the diagnosis of insomnia and may contribute to decrypting the source of variation and predictive variables in pain and sleep interaction [37,100]. Although actigraphy/PSG is a simple and more practical tool, users have to recognize some of its limitations, such as the lower estimation value for sleep efficiency in the specific population with poor sleep and/or sleep disturbances [82]. In conclusion for this section, subjective sleep complaints often do not match the objective measurement of sleep by PSG or actigraphy. This was a robust finding that Tang et al. [37] addressed and is particularly true for pain patients [26,37]. Therefore, the choice of an instrument primarily depends on the interest of the researcher or clinician and whether they are collecting objective or subjective data concerning sleep.

#### 4.2.1. One or several instruments?

Clinicians and researchers face the challenge of deciding on the number of instruments needed. As shown by Mondal et al., only limited associations exist between the PSQI and the ESS, although the authors expected the level of association between these two instruments to be high because of the characteristics of their study sample. They assessed patients who were referred for PSG by sleep-medicine physicians and expected this population to be at high risk of sleep disorders and consecutive daytime sleepiness [63]. As was expected, the two questionnaires evaluated the different dimensions of sleep that were only related in a subgroup of patients with SAS. This example illustrates that if the focus lies on global assessments of sleep disturbances, the inclusion of instruments measuring different facets of sleep disturbances is recommended.

#### 4.2.2. Debate of the instruments used in the selected TMD/OFP studies

Questionnaires were the most common type of self-reported instruments employed in the eligible studies. Only one study used an interview, and no studies used a sleep diary. As stated previously, the eight instruments identified in the 26 studies that were evaluated differed substantially in their clinimetric evaluation (Table 4). This fact may also be reflected by the large variations in the number of citations (Fig. 2). All questionnaires used were self-administered and patients found them easy to complete. Scoring was simple and interpretation was accessible in most studies.

According to the studies surveyed, insomnia, SAS, and SB seemed to be the most frequent types of sleep disorders, while poor sleep quality and excessive daytime sleepiness seem to be the most frequent complaints of TMD/OFP patients. Concerning insomnia symptoms, the most common sleep-related complaints of pain patients were delayed sleep onset, restless sleep, frequent awakenings and NRS. Apart from ISI, none of the seven other instruments focused directly on these sleep problems. In contrast, Cole et al. [81] recommend the use of the MOS Sleep Scale [101], mainly because of its validated dimension and score for sleep disturbance. This subscale consists of four items asking for: trouble falling asleep, sleep restlessness, awaken during sleep, and time to fall asleep. Furthermore, SB and its impact on sleep disturbances and sleep quality was not addressed by any of the instruments used. Although SB may not be related to TMD [95,102], a significant association between SB and insomnia was detected both in TMD and general population studies [10,27]. The debate on the association between sleep-related movement disorders, such as SB, and impaired sleep quality and/or insomnia remains to be tested with more specific questionnaires assessing pre-sleep cognitive and somatic arousal [6,33,37].

The SDQ and the Fletcher and Luckett Questionnaire were used to directly assess SAS, although instruments like the Berlin Questionnaire, the STOP, and the STOP-Bang questionnaires are more frequently used and provide better clinimetric performance [77,92]. The ESS has a high validation for EDS, but its diagnostic efficiency for SAS is inconclusive because it only assesses a possible consequence of SAS [60,103].

Nevertheless, recommendations concerning the 'right' selection of questionnaires are problematic because the process of selecting questionnaires in studies on sleep disturbances has to involve considerations concerning the kind of study anticipated and the theory underlying the sleep disturbance being addressed [61,81]. In order to facilitate this selection process, the purpose of each instrument is listed in Tables 2 and 3 according to the conceptual framework of sleep dysfunction defined by Moul et al. [61].

#### 4.2.3. Conclusions and future research

The validity of PSG for diagnosing sleep disturbances is undisputed (either in a laboratory or at home). However, its utility is constrained by availability, patient inconvenience and cost. Sufficiently validated questionnaires, on the other hand, are easily administered and cost-effective information-gathering tools that aid clinicians in their decision-making process. As previously explained, they do not need to be validated in TMD/OFP patients, as long as their clinimetric properties are adequately established elsewhere. From a biomedical perspective, a short and practical questionnaire for TMD/OFP should include at least the following: sleep quality, insomnia symptoms (night and day), teeth grinding awareness, and sleep breathing disorder-related items. Future studies on the relationship between sleep disturbances and chronic pain in patients with TMD/OFP will likely have to include mediator variables such as cognitive and emotional arousal [10,104]. As shown by Buenaver, the relationship between pain and sleep may be conceptualized as a network composed of direct and indirect pathways, with the rumination component of pain indirectly contributing to TMD pain through alterations in self-reported sleep [105]. Lautenbacher identified failures in problem solving (a cognitive dysfunction typically associated with depression) as a further possible indirect pathway [106]. The view on the different pathways linking sleep and pain in TMD/OFP patients has thus to be expanded toward a biopsychosocial framework, considering that cognitive (eg, unwanted mental activity at bedtime, which can take the form of verbal thought or visual imagery [107]) as well as affective factors (eg, anger, irritability, catastrophizing [14,100,102,108–111]) play an important role in the sleep–pain network [33,37].

Considering the aforementioned factors, it can be concluded that reliance on a purely biomedical model of sleep disturbances and chronic pain might not fully account for all aspects of their intercorrelation or relationship. To date, for patients suffering from TMD/OFP, little is known about the pathways linking cognitive and emotional arousal with chronic pain and sleep disturbances. In order to address these aspects adequately, there might be a need for the development of new instruments. Existing instruments that measure cognitive and affective arousal might be used, such as the "Fragebogen zur Erfassung allgemeiner und spezifischer Persönlichkeitsmerkmale Schlafgestörter" [112] or the Anxiety and Preoccupation about Sleep Questionnaire [113]. Instruments that measure attempts to control thoughts, such as the Thought-Control Questionnaire Insomnia-Revised [102], may also be used. This future research direction would blend into the overall biopsychosocial concept of TMD/OFP diagnoses and treatment [114,115].

## Conflict of interest

The authors declare that there are no direct conflicts of interest, and no grant or salary support from an agency related to this paper, with the exception of a governmental Canada Research Chair to GL.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: http://dx.doi.org/10.1016/j.sleep.2014.07.023.

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